

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

**Listing of Claims:**

1-23. (Cancelled).

24. (Previously presented) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board comprising at least  $2N$  layers and further comprising at least  $2N$  circuit board surfaces, whereby  $N$  is an integer greater than 2;

a plurality of radial metal foils on each of  $2N$  of the at least  $2N$  circuit board surfaces, each metal foil extending along an axis that radiates from approximately the center of the opening;

$N$  windings, each winding formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces in a thickness direction of the printed circuit board; wherein a first winding is comprised of metal foils on a board top surface and a board bottom surface;

$N$  return circuit lines; wherein the return circuit lines are approximately circular metal foils with a center that is approximately the center of the opening; each of the return circuit lines being electrically connected with one of the  $N$  windings in series to form  $N$  winding – return circuit line pairs;

wherein the  $N$  winding – return circuit line pairs are in turn connected in series with one another.

25. (Previously presented) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board comprising at least  $2N$  layers and further comprising at least  $2N$  circuit board surfaces, whereby  $N$  is an integer greater than 2;

a plurality of radial metal foils on each of  $2N$  of the at least  $2N$  circuit board surfaces, each metal foil extending along an axis that radiates from approximately the center of the opening;

$N$  windings, each winding formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces in a thickness direction of the printed circuit board; wherein a first winding is comprised of metal foils on a board top surface and a board bottom surface;

$N$  return circuit lines; wherein the return circuit lines are approximately circular metal foils with a center that is approximately the center of the opening; each of the return circuit lines being electrically connected with one of the  $N$  windings in series to form  $N$  winding – return circuit line pairs;

wherein the return circuit lines also comprise windings that are wound oppositely to the  $N$  windings;

and wherein the  $N$  winding – return circuit line pairs are in turn connected in series with one another.

26. (New) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board comprising at least  $N$  circuit board surfaces, whereby  $N$  is at least four;

a plurality of radial metal foils, with at least one foil disposed on each of at least four circuit board surfaces, each metal foil extending along an axis that radiates from approximately the center of the opening;

W windings, where W is at least 2, each winding formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces in a thickness direction of the printed circuit board; wherein a first winding is comprised of metal foils on a board top surface and a board bottom surface;

W return circuit lines; wherein the return circuit lines are approximately circular metal foils with a center that is approximately the center of the opening; each of the return circuit lines being electrically connected with one of the W windings in series to form W winding – return circuit line pairs;

wherein the W winding – return circuit line pairs are in turn connected in series with one another.

27. (New) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board comprising at least N circuit board surfaces, whereby N is at least four;

a plurality of radial metal foils on each of four of the circuit board surfaces, each metal foil extending along an axis that radiates from approximately the center of the opening;

W windings, each winding formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces in a thickness direction of the printed circuit board; wherein a first winding is comprised of metal foils on a board top surface and a board bottom surface;

W return circuit lines; wherein the return circuit lines are approximately circular metal foils with a center that is approximately the center of the opening; each of the return circuit

lines being electrically connected with one of the W windings in series to form W winding – return circuit line pairs;

wherein the return circuit lines also comprise windings that are wound oppositely to the N windings;

and wherein the W winding – return circuit line pairs are in turn connected in series with one another.

28. (New) A current transformer, comprising a Rogowski coil, having an opening at the center in which a conductor penetrates, further comprising:

a printed circuit board comprising at least N circuit board surfaces, whereby N is at least four;

a plurality of radial metal foils with at least one foil disposed on each of at least four circuit board surfaces, each metal foil extending along an axis that radiates from approximately the center of the opening;

W windings, where W is at least 2, each winding formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces in a thickness direction of the printed circuit board;

W return circuit lines, wherein the return circuit lines traverse an approximately circular path with a center that is approximately the center of the opening; each of the return circuit lines being electrically connected with one of the windings in series to form W winding – return circuit line pairs;

wherein the W winding – return circuit line pairs are in turn connected in series with one another.

29. (New) The current transformer of claim 28,

wherein the W return circuit lines further comprise W return-circuit windings formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces; and

wherein the W return circuit windings are wound oppositely to the W windings.

30. (New) The current transformer of claim 28, wherein the W return circuit lines comprise W approximately circular metal foils disposed on a single board surface.

31. (New) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board having at least first to fourth circuit board surfaces including a circuit board top surface, a circuit board bottom surface and circuit board conducting internal surfaces between the circuit board top surface and the circuit board bottom surface;

a plurality of radial metal foils, each metal foil radiating from a center that is approximately the center of the opening, mounted on the first to fourth circuit board surfaces;

a first winding formed by electrically connecting metal foils on the first and second circuit board surfaces with first plated through holes penetrating the first and second circuit board surfaces in a thickness direction of the printed circuit board;

a second winding formed by electrically connecting metal foils on the third and fourth circuit board surfaces with second plated through holes penetrating the third and fourth circuit board surfaces in a thickness direction of the printed circuit board;

a first return circuit line electrically connected with the first winding in series;

a second return circuit line electrically connected with the second winding in series;

and

a pair of the first winding and the first return circuit line and a pair of the second winding and the second return circuit line being electrically connected in series.

32. (New) The current transformer in Claim 31, wherein the first return circuit line and the second return circuit line are first and second circular metal foils with a center that is the center of the opening.

33. (New) The current transformer in Claim 32, wherein a total number of windings, including the first winding and the second winding, equals a total number of return circuit lines, including the first return circuit line and the second return circuit line, and wherein the first return circuit line and the second return circuit line are formed on the same circuit board surface.

34. (New) The current transformer in Claim 32, wherein a total number of windings, including the first winding and the second winding, equals a total number of return circuit lines, including the first return circuit line and the second return circuit line, and the first return circuit line is formed on a fifth circuit board surface of the plurality of layers, and the second return circuit line is formed on a sixth circuit board surface of the plurality of layers.

35. (New) The current transformer of claim 31, wherein the first circuit board surface is the circuit board top surface, the second circuit board surface is a circuit board internal surface, the third circuit board surface is the circuit board bottom surface, and the fourth circuit board surface is a circuit board internal surface.

36. (New) The current transformer of claim 31, wherein the first circuit board surface is the circuit board top surface, the second circuit board surface is the circuit board bottom surface, the third circuit board surface is a circuit board internal surface, and the fourth circuit board surface is a circuit board internal surface.

37. (New) The current transformer in Claim 31, wherein the Rogowski coil comprises:

N windings, including the first and second windings, each formed by electrically connecting the radial metal foils on a respective pair of the circuit board surfaces with plated through holes penetrating the pair of circuit board surfaces in a thickness direction of the printed circuit board, N being an integer greater than one;

N return circuit lines, including the first and second return circuit lines; each return circuit line being formed on at least one of the circuit board surface; and

the N windings and the N return circuit lines being electrically connected in series.

38. (New) The current transformer in Claim 37, wherein each of the N return circuit lines is a return winding formed by electrically connecting radial metal foils on a respective pair of the circuit board surfaces with plated through holes penetrating the pair of circuit board surfaces in a thickness direction of the printed circuit board, and is wound in a direction opposite to a direction in which the N windings are wound.

39. (New) The current transformer in Claim 38, wherein the Rogowski coil further comprises:

a first multiple winding formed by connecting a first group of the windings to each other in series; and

a second multiple winding formed by connecting a second group of the return windings to each other in series,

wherein the first multiple winding and the second multiple winding are connected to each other so that the first multiple winding is a mirror image of the second multiple winding on the printed circuit board.

40. (New) The current transformer in Claim 39, wherein the plurality of layers include  $(4N+2)$  circuit board surfaces, on each of which the plurality of radial metal foils are formed, N being an integer not smaller than one, and a fifth circuit board surface, and wherein

the first return circuit line is a first circular metal foil on the fifth circuit board surface with a center that is approximately the center of the opening, and wherein the Rogowski coil further comprises:

(N+1) windings, including the first and second windings, each winding being formed by electrically connecting the radial metal foils on a respective pair of the circuit board surfaces with plated through holes penetrating the pair of circuit board surfaces in a thickness direction of the printed circuit board;

N return circuit lines, including the second return circuit line, each return circuit line being a return winding formed by electrically connecting radial metal foils on a respective pair of the circuit board surfaces with plated through holes penetrating the pair of circuit board surfaces in a thickness direction of the printed circuit board, and being wound in a direction opposite to a direction in which the (N+1) windings are wound; and

the (N+1) windings, the N return windings, and the first circular metal foil being electrically connected in series.

41. (New) The current transformer as recited in Claim 31, wherein the Rogowski coil comprises a plurality of the printed circuit boards, arranged so that corresponding center axis openings of respective printed circuit boards are aligned with each other, and the windings formed on the respective printed circuit boards are connected to each other in series.

42. (New) The current transformer in Claim 31, further comprising:

a sensor unit, comprising,

an analog-to-digital converter which converts the analog-voltage signal into a digital electric signal, and

an electric-to-optic converter which converts the digital electric signal into a digital optical signal; and

an optical transmission unit which transmits the digital optical signal to upstream system.



43. (New) The current transformer in Claim 42, wherein a number of the Rogowski coils, a number of the sensor units, and a number of the optical transmission units are each more than one, and the current transformer further comprises:

a merging unit which merges a plurality of the digital optical signals outputted from the respective Rogowski coils through the respective sensor units to generate at least one merged transmission signal, and transmits the merged transmission signal to the upstream system.

44. (New) The current transformer in Claim 43, wherein the merging unit comprises:

a plurality of optic-to-electric converters, each of which converts the respective digital optical signals into a second digital electric signal;

a second merging unit which merges the respective second digital electric signals to generate at least one second electrical merged transmission signal; and

a second electric-to-optic converter which converts the second electrical merged transmission signal into a second digital optical signal.

45. (New) The current transformer in Claim 43, wherein the merging unit and the upstream system are connected through a point-to-point transmission channel.

46. (New) The current transformer in Claim 44, wherein the merging unit and the upstream system are connected through a local area network.

47. (New) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board having a plurality of layers forming at least  $2N+1$  circuit board surfaces including a circuit board top surface, a circuit board bottom surface and circuit board

internal surfaces between the circuit board top surface and the circuit board bottom surface, N being an integer more than one;

N windings, each formed by electrically connecting the radial metal foils on a respective pair of circuit board surfaces with plated thorough holes penetrating the pair of circuit board surfaces in a thickness direction of the printed circuit board; and

a return circuit line formed on a circuit board surface, electrically connected with at least one of the N windings in series.

48. (New) The current transformer in Claim 47, wherein the return circuit line is a circular metal foil with a center that is approximately the center of the opening.

49. (New) The current transformer in Claim 47, wherein the return circuit line is set between two windings, and at least one of the N windings and the return circuit line are electrically connected in series.

50. (New) The current transformer in Claim 47, wherein the Rogowski coil further comprises:

a first multiple winding formed by connecting a first group of windings to each other in series;

a second multiple winding formed by connecting a second group of windings to each other in series,

wherein the first multiple winding and the second multiple winding are connected to each other so that the first multiple winding is a mirror image of the second multiple winding on the printed circuit board.

51. (New) A current transformer, comprising:

a Rogowski coil, having a opening at the center in which a conductor penetrates, comprising:

a printed circuit board having a plurality of layers forming at least  $2N$  board surfaces including a circuit board top surface, a circuit board bottom surface and circuit board internal surfaces between the circuit board top surface and the circuit board bottom surface,  $N$  being an integer greater than one; and

$N$  windings, each formed by electrically connecting the radial metal foils on a respective pair of circuit board surfaces of with plated through holes penetrating the pair of circuit board surfaces in a thickness direction of the printed circuit board,

wherein the  $N$  windings are connected in series.

52. (New) The current transformer in Claim 51, wherein a first one of the  $N$  windings is wound in a direction opposite to a direction in which a second one of the  $N$  windings is wound.

53. (New) The current transformer in Claim 51, wherein one of the  $N$  windings is set between two other ones of the  $N$  windings.

54. (New) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board comprising at least  $2N$  circuit board surfaces, whereby  $N$  is an integer greater than 2;

a plurality of radial metal foils with at least one foil disposed on each of at least four circuit board surfaces, each metal foil extending along an axis that radiates from approximately the center of the opening;

$W$  windings, where  $W$  is at least 2, each winding formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces in a thickness direction of the printed circuit board;

W return circuit lines; wherein the return circuit lines are approximately circular metal foils with a center that is approximately the center of the opening; each of the return circuit lines being electrically connected with one of the W windings in series to form W winding – return circuit line pairs;

wherein the return circuit lines also comprise windings that are wound oppositely to the W windings.

55. (New) A current transformer, comprising:

a Rogowski coil, having an opening at the center in which a conductor penetrates, comprising:

a printed circuit board comprising at least 4N circuit board surfaces, whereby N is at least 1;

a plurality of radial metal foils with at least one foil disposed on each of at least four of circuit board surfaces, each metal foil extending along an axis that radiates from approximately the center of the opening;

N windings, each winding formed by electrically connecting metal foils on a respective pair of circuit board surfaces with plated through holes penetrating the circuit board surfaces in a thickness direction of the printed circuit board; wherein Nth windings comprise metal foils on adjacent circuit board surfaces;

N return circuit lines; wherein the return circuit lines are approximately circular metal foils with a center that is approximately the center of the opening; each of the return circuit lines being electrically connected with one of the N windings in series to form N winding – return circuit line pairs;

wherein the return circuit lines also comprise windings that are wound oppositely to the N windings;

and wherein the N winding – return circuit line pairs are in turn connected in series with one another.